WETLAND JURISDICTIONAL DETERMINATION, Federal Aviation Administration, Homer (HHW) Facility, Guarico Ward, Guarico Ward, Vega Baja, Puerto Rico.

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I. EXECUTIVE SUMMARY

A wetland jurisdictional delineation was conducted at a parcel of approximately 32 acres of land adjacent to state highway PR 687, in the Guarico Sector at the Municipality of Vega Baja. FAA manages and operates the HHW Facilities at the Guarico Ward, which serves as aviation beacon for island and Caribbean air traffic. This parcel is approximately 32 acres. The parcel is located on the northern coast of Puerto Rico about 40 km east of Arecibo and 25 km west of San Juan. Warm wet summers and cooler dry winters with an average annual precipitation of 82 inches characterize the climate. The geology of the area is dominated by blanket sand deposits and swamp deposits. The principal soil units within the parcel are Corozo fine sand and Algarrobo fine sands with some influence of the Tiburones muck.

The Wetland delineation was conducted following the guidelines of the 1987 US Army Corps of Engineers Wetland Delineation Manual. A "Routine Approach, On-site Inspection" was used for this jurisdictional delineation. This wetland jurisdictional delineation was developed by; characterizing the vegetation, soils and hydrology of the study area.

The analysis of the field data showed that the existing upland “peninsula” is covered with coastal forest vegetation at higher elevation and surrounded by herbaceous wet vegetation except to the west. The study area is leveled through the topography of the landscape. Sandy soils dominate the uplands while muck soils sustain the wet vegetation.

II. INTRODUCTION

FAA manages and operates the HHW Facilities at the Guarico Ward, which serves as aviation beacon for island and Caribbean air traffic. FAA is pursuing land acquisition (see Figure 1). Figure 2 and Figure 3 provides Aerial Images of the site (2002, 2004).

A Jurisdictional Determination was commissioned by Gregory Morris Engineers to EA Environmental Consultants & Services to delineate potential existing wetlands.

This report contains the results of a wetland jurisdictional delineation for the property studied in Vega Baja, Puerto Rico. The procedures outlined in the 1987 Corps of Engineers Wetland Delineation Manual were followed. As part of the delineation, the available literature including published FWS, Planning Board, NRCS, DNER and technical journal/articles were revised. In addition sampling of soils, vegetation and hydrology was collected systematically along the study area.

III. GENERAL DESCRIPTION OF STUDY AREA

A. Site Location and Landscape Features

The proposed project is located in an area of approximately 32 acres at Barrio Guarico in the Municipality of Vega Baja, Puerto Rico. The study area is located on east of road PR#687. Refer to Figure 1 Location Map and Figure 2 and Figure 3 Aerial Images

B. Geology

The study area lies in the Northern coastal plateau of Puerto Rico. The study area contains Blanket Sand Deposits (QTbs) and Swamp Deposits (Qs) from the Oligocene to Holocene. West of the study area we have Aymamon Limestone (Tay). See Figure 4 Geologic map for the Manati area.

- QTbs Blanket deposits, sand clayey ferruginous, fine to medium sand found on ridges of limestone; a superficial sand that has been lowered by solution of underlying limestone.
- Qs Swap deposits, clay, sandy clay and muck, commonly underlain by peat. Includes some mangrove swamps. Some areas that have been drained consist of carbonaceous sandy clay.
- Tay Aymamon Limestone, white to very pale orange, locally pale yellow and grayish pink, massive to thick embedded very pure fossiliferous limestone generally indurated by secondary cementation into finely crystalline rather than dense limestone

C. Soils

The Arecibo Soil Survey shows the prevalence of Corozo fine sand and Algarrobo fine sands soils, some Tiburones muck intrusions are evident. Surrounding soils includes San German gravely clay and Vigia Muck. See Figure 5 Soils map for the Guarico area. The following soil series were found in the study area:

- Tb Tiburones Muck: This soil is deep, nearly level and poorly drained. It is on the bottomlands and in depressional areas of the coastal lowlands. Most areas are in water tolerant plants and native pasture. Wetness is the mail limitation of the soil for non farm development.

- AgC Algarrobo fine sand: 2 to 12 percent slopes. This soil is deep, gently sloping to sloping and excessively drained. It is on coastal plains. Slopes range from 100 to 400 feet long. The permeability of this Algarrobo soil is rapid in the upper part and slow in the lower part.

- CsC Corozo fine sand, 2 to 12 percent slopes: This soil is deep, gently sloping to sloping, and well drained. It is on coastal plains. The permeability of this Corozo soil is rapid on the surface and subsurface layers and slow in the subsoil. Runoff is slow. The available water capacity is low.

Table 1: General characteristics of the soils in the studied area.
(Adopted from the U.S. Department of Agriculture, Soil Conservation Service).

Map Symbol	Soil Name	Depth (in)	Shrink Swell Potential	Permeability (in. Per hour)	Available Water Capacity (cm/ per cm of soil)	Soil React (pH)
CsC	Corozo fine sand	0-60	Very low	>20	.05 - .08	3.6-5.5
AgC	Algarrobo fine sand	0-80	Very low	>0.2	.05 - .08	3.6-5.5
Tb	Tiburones Muck	0-84	Low	0.06-0.2	0.15-0.20	4.5-7.3

D. Climatology

The study area is located in the humid subtropical zone. The average annual rainfall is 82" and the average annual temperature is 78F. Rainfall is more frequent during the months of July to October. The average relative humidity is 80%. Predominant winds direction is northeast. The area is subject to the influence of marine breeze.

E. Flora and Fauna

During the assessment we a list of plant and animal species was recorded along the sampling array. A list of species is provided as baseline data obtained during the field visits. A revision for the FWS Wetland Inventory map and the State Natural Heritage database was done to verify species or habitats of concern in the area. Figure 6 and Figure 7 shows the FWS WI Map and the Natural Heritage area map.

Table 2: Flora Composition List for the study site.

#	Scientific Name	Common Name	Family	Habit
1	Acrocomia media	Corozo	Palmae	Tree
2	Aeschynomene sensitiva	Morivivi bobo	Fabaceae	Herbaceous
3	Albizia lebeck	Albizia	Fabaceae	Tree
4	Alysacarpus vaginalis	Yerba de contrabando	Fabaceae	Herbaceous
5	Anacardium occidentale	Cashew	Anacardiacea	Tree
6	Andira inermis	Moca	Fabaceae	Tree
7	Antigonon leptopus	Bellisimagrnde	Polygonaceae	Herbaceous
8	Axonopus compressus	Yerba colorada	Poaceae	Herbaceous
9	Bidens alba	Margarita	Asteraceae	Herbaceous
10	Bidens pilosa	Margarita	Asteraceae	Herbaceous
11	Blechnum serrulatum	Fern	Polypodiaceae	Herbaceous
12	Brachiaria mutica	Malojillo	Poaceae	Herbaceous
13	Brachiaria purpurecens	Malojillo	Poaceae	Herbaceous
14	Bursera simarouba	Almacigo	Burseracea	Tree
15	Calophyllum calaba	Maria	Guttiferacea	Tree
16	Cassia suratensis	Cassia	Caesalpinaceae	Shrub
17	Centella erecta	Yerba de clavo	Umbelliferacea	Herbaceous
18	Centrosema pubescens	habichuela	Fabaceae	Herbaceous
19	Centrosema virginianum	habichuela	Fabaceae	Herbaceous
20	Chamaechrista rotundifolia	Tamarindillo	Caesalpinaceae	Herbaceous
21	Chamaesyce hyssopifolia	Lechecillo	Euphorbiaceae	Herbaceous

22	Chrysoblanus icaco	Sea plum	Chrysoblanaceae	Tree/Shrub
23	Citharexylum fruticosum	Pendula	Verbenaceae	Tree
24	Cladium jamaicensis	saw grass	Cyperaceae	Herbaceous
25	Clidemia hirta	Camasey	Melastomataceae	Herbaceous
26	Clusia rosea	Cupey	Clusiacea	Tree
27	Cocos nucifera	Coconut Palm	Palmae	Tree
28	Commelina diffusa	Cohitre	Commelinaceae	Herbaceous
29	Conyza canadensis	Milhojas	Asteraceae	Herbaceous
30	Crotolaria incana	Matraca	Fabaceae	Herbaceous
31	Cynodon nlemfuensis	Grama Bermuda	Poaceae	Herbaceous
32	Cyperus distans	Junco	Cyperaceae	Herbaceous
33	Cyperus elegans	Junco	Cyperaceae	Herbaceous
34	Cyperus flavus	Junco	Cyperaceae	Herbaceous
35	Cyperus laevigatus	Junco	Cyperaceae	Herbaceous
36	Cyperus ligularis	Junco	Cyperaceae	Herbaceous
37	Cyperus odoratus	Junco	Cyperaceae	Herbaceous
38	Cyperus surinamensis	Junco	Cyperaceae	Herbaceous
39	Desmantus virgatus	Desmanto	Fabaceae	Herbaceous
40	Desmodium incanum	Zarzabacoa	Fabaceae	Herbaceous
41	Digitaria ciliaris	Pata de gallina	Poaceae	Herbaceous
42	Digitaria decumbens	Pangola	Poaceae	Herbaceous
43	Diodia rigida	Poaya	Rubiaceae	Herbaceous
44	Echinocloa colonum	Arrocillo	Poaceae	Herbaceous
45	Eleocharis sp		Cyperaceae	Herbaceous
46	Eugenia biflora	Hoja menuda	Myrtaceae	Tree
47	Euphorbia heterophylla	Leche vana	Euphorbiaceae	Herbaceous
48	Ficus citrifolia	Jaguey	Moraceae	Tree
49	Galactia striata	Galactia	Fabaceae	Herbaceous
50	Gliricidia sepium	Mata Raton	Fabaceae	Herbaceous
51	Hedyotis corymbosa	Graciosa	Rubiaceae	Herbaceous
52	Hymenae courbaril	cabob	Leguminoseae	Tree
53	Hypoxis sp		Hypoxidaceae	Herbaceous
54	Indigofera subfruticosa	Anil	Fabaceae	Herbaceous
55	Ipomea violácea	Bejuco de puerco	Convolvulaceae	Vine
56	Jatropha gossypifolia	Tua Tua	Euphorbiaceae	Herbaceous
57	Lippia nodiflora	Cape weed	Verbenaceae	Herbaceous
58	Ludwigia octovalvis	Yerba de jicotea	Onagraceae	Herbaceous
59	Malachra sp.	Malva	Malvaceae	Herbaceous
60	Merremia quinqueifolia	yuquilla	Convolvulaceae	Herbaceous
61	Miconia prasina	Camasey	Melastomataceae	Tree
62	Mikania micrantha	Guaco falso	Asteraceae	Herbaceous
63	Miryca cerifera	Bay Berry	Myricaceae	Tree
64	Momordica charantia	Cundeamor	Cucurbitaceae	Herbaceous
65	Nephrolepis multiflora	Fern	Polipodiaceae	Herbaceous
66	Ouratea litorales	Abey amarillo	Ochnaceae	Tree
67	Panicum sp	Pangola grass	Poaceae	Herbaceous

68	Paspalum millegrana	Gramalota	Poaceae	Herbaceous
69	Paspalum notatum	Horquetilla	Poaceae	Herbaceous
70	Passiflora suberosa	Wild Passionfruit	Passifloraceae	Vine
71	Phyllanthus amarus	Hierba	Euphorbiaceae	Herbaceous
72	Physalis sp.	Sacabuche	Solanaceae	Herbaceous
73	Randia aculeata	Tintillo	Rubiaceae	Shrub
74	Rhynchosia phaseoloides	Frijolillo	Fabaceae	Herbaceous
75	Rhynchospora gigantea	Frijolillo	Fabaceae	Herbaceous
76	Schefferra morototonii	Yagrumo Macho	Araliaceae	Tree
77	Scoparia dulcis	Escoba amarga	Schrophulariaceae	Herbaceous
78	Senna siamea	Casia amarilla	Fabaceae	Tree
79	Sesbania sericea	Papagayo	Fabaceae	Shrub
80	Sida cordifolia	Escoba acorazonada	Malvaceae	Herbaceous
81	Sida glomerata	Escoba de palma	Malvaceae	Herbaceous
82	Spathodea camapnulata	African Tulip	Bignonaceae	Tree
83	Spermacoce verticilata	Boton blanco	Rubiaceae	Herbaceous
84	Sporobolus jacquemonti	Cerrillo	Poaceae	Herbaceous
85	Stachytarpheta jamaicensis	Bretonica	Verbenaceae	Herbaceous
86	Stenotaphrum secundatum		Poacea	Herbaceous
87	Tabebuia heterophylla	Roble	Bignoniacea	Tree
88	Tephrosia cinerea	Anil	Fabaceae	Shrub
89	Terminalia cattapa	Almendra	Combretaceae	Tree
90	Tricostigma octandrum	Bejuco de masa	Phytolacaceae	Vine
91	Tridax procumbens	Pancha	Asteraceae	Herbaceous
92	Typha dominguensis	Enea	Poaceae	Herbaceous
93	Urena lobata	Cadillo	Malvaceae	Herbaceous
94	Urochloa maxima	Yerba guinea	Poaceae	Herbaceous
95	Vernonia cinerea	Yerba socialista	Asteraceae	Herbaceous
96	Vigna vexilata	Frijol Cimarron	Fabaceae	Herbaceous
97	Wedelia trilobata	Wedelia	Asteraceae	Herbaceous
98	Xenostegia tridentata	Hierba	Convolvulaceae	Herbaceous
99	Zornia reticullata	Zarzabacoa	Fabaceae	Herbaceous

Table 3: Fauna of the study site

VERTEBRATES			
Class	**Family**	**Genus/species**	**Common name (Spanish)**
Amphibia	Bufonidae	Bufo marinus	sapo
Amphibia	Leptodactylidae	Eleutherodactylus portoricensis	coquí
Amphibia	Leptodactylidae	Leptodactylus albilabris	rana labio blanco
Reptilia	Iguanidae	Iguana iguana	iguana verde
Reptilia	Iguanidae	Anolis cristatellus	lagartijo
Reptilia	Iguanidae	Anolis pulchelus	lagartijo de jardín
Aves	Ardeidae	Butorides virescens	Martinete
Aves	Ardeidae	Ardea alba	Garza Real

Aves	Ardeidae	Bubulcus ibis	garza ganadera
Aves	Rallidae	Gallinula chloropus	Gallareta Común
Aves	Falconidae	Falco sparverius	falcón comun
Aves	Picidae	Melanerpes portoricensis	Carpintero de Puerto Rico
Aves	Columbidae	Columbina passerina	rolitade P. R.
Aves	Columbidae	Zenaida asiatica	tórtola aliblanca
Aves	Tyranidae	Tyranus dominicensis	pitirre
Aves	Mimidae	Mimos polyglotus	ruiseñor
Aves	Mimidae	Margarops fuscatus	zorzal pardo
Aves	Emberizidae	Coereba flaveola	reinita comun
Aves	Emberizidae	Tiaris bicolor	Gorrion negro
Aves	Emberizidae	Ammodramus savannarum	chamorro
Aves	Emberizidae	Tiaris olivacea	Gorrión Barba Amarilla
Aves	Icteridae	Quiscalus niger	chango
Aves	Estrilididadae	Estrilda melpoda	veterano
Aves	Estrilididadae	Lonchura cucullata	diablito
Aves	Ploceidae	Euplectes orix	obispo

INVERTEBRATES

Class	Family	Genus/species	Common name (Spanish)
Gastropoda		Megalmastoma sp.	caracol
Gastropoda	Bulimulidae	Bulimulus sp.	caracol
Arachnida	Araneida	Argiope argentata	araña
Arachnida	Araneidae	Unknown species	araña
Insecta	Libellulidae	Orthemis ferruginea	libelulas
Insecta	Coenagrionidae	Unknown species	damselflies
Insecta	Chrysopidae	Unknown species	lacewing
Insecta	Unknown	Unknown species	caddisflies
Insecta	Acrididae	Schistocerca americana	saltamonte
Insecta	Acrididae	Rhammatocereus gregarius	saltamonte
Insecta	Gryllidae	Orochalis vaginalis	grillo
Insecta	Blattidae	Pycnoscelus sp.	cucaracha
Insecta	Buprestidae	Desconocido	escarabajo
Insecta	Scarabaeidae	Phyllophaga sp.	escarabajo
Insecta	Carabidae	Unknown species	escarabajo
Insecta	Carabidae	Unknown species	escarabajo
Insecta	Coccinelidae	Coccinella novemnotata	mariquita
Insecta	Scarabaeidae	Unknown species	escarabajo
Insecta	Scarabaeidae	Unknown species	escarabajo
Insecta	Chrysomelidae	Unknown species	escarabajo
Insecta	Pieriidae	Phoebis sp.	mariposa
Insecta	Danaidae	Danaus plexipus	monarca
Insecta	Nymphalidae	Heliconius charitonius	mariposa
Insecta	Nymphalidae	Colfitalaria sp.	mariposa
Insecta	Arctidae	Utetheisa bella	alevilla
Insecta	Culicidae	Aedes aegyptii	mosquito
Insecta	Formicidae	Solenopsis invicta	hormiga
Insecta	Anthophoridae	Xylocopa brasilianorum	cigarron
Insecta	Apidae	Apis melifera	abeja

Endangered and threatened species in Puerto Rico are protected by two regulations:

- Regulations for the Conservation and Management of Threatened and Endangered Species in the Commonwealth of Puerto Rico (Department of Natural Resources, 1985, 2004), and;
- The Endangered and Threatened Wildlife and Plants Rule (50 CFR 17.11 and 17.12, August 20, 1994).

As part of the regulations endangered species, threatened species, species similar to endanger and threatened species and their habitats are protected. The PRDNER Regulations for the Management of Threatened and Endangered Species in the Commonwealth of Puerto Rico (Department of Natural Resources, 1985, 2004) refers to these species by the collective name "Critical Biological Species" and catalogs them by status.

The following statuses are recognized:

- E; Species determined by the local authorities to be endangered.
- EF; Species determined by Federal authorities to be endangered.
- V; Species determined by local authorities to be threatened.
- VF; Species determined by Federal authorities to be threatened.
- NHDCE; Species adopted by the PRDNER Natural Heritage Division as a critical element because of its similarity to a threatened or endangered species.

The Natural Heritage Division inventories were reviewed for the occurrence of critical biological species in the study area. **No listed species were found within the studied area.**

F. Hydrology

The study area hydrology is driven by the high table water level and the influence of tides and heavy rain events. Laguna Tortuguero is west of the property. Drainage channels are evident from the aerial imagery. At the landscape level, the dominant sandy soils in the property provide very good drainage. Lower elevations surrounding the property with muck soils and its poor drainage characteristics provide excellent conditions for hydric plants to establish and dominate the landscaped. Figure 6 provides the Wetland Inventory Map.

G. Cultural Resources

No obvious elements associated to pre-Columbian or historic settlements were found. A general land use analysis shows evidence of human utilization. During the 40's and 60's the area was used as an armed forces training center. Nonetheless a specialized study should be conducted as needed to acquire more cultural resources information.

IV. DELINEATION AND DESCRIPTION OF THE WETLANDS

This section of the report includes; (1) a jurisdictional delineation of the wetlands occurring in the parcel that comprises the study area, (2) a qualitative and quantitative description of the wetlands plant composition, soils and hydrology, and (3) an evaluation of the wetland functional values.

According to the U.S. Fish and Wildlife National Wetland Inventory (Figure 6), the study site is composed of small areas uplands and extensive wetlands.

The protocols described in the 1987 USA CoE Wetland Delineation Manual were followed in the jurisdictional delineation of these wetlands. The USA CoE (Federal Register 1982) and the U.S. Environmental Protection Agency (Federal Register 1980) jointly defined wetlands as *"those areas that are inundated by surface water or ground water at a frequency and duration to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".*

According to the above definition, wetlands have the following diagnostic environmental characteristics: (1) hydrophitic vegetation, (2) hydric soils, and (3) hydrographic regime resulting in saturated or flooded conditions. The USA CoE considers an area a jurisdictional wetland only when a positive wetland indicator is present for each of the diagnostic environmental characteristics (USA CoE, 1987).

Wetlands

In general terms, wetlands are habitats between terrestrial and aquatic ecosystems where standing waters or saturated soil conditions occur at least periodically and where a prevalence of vegetation typically adapted for anoxic soil conditions occur. Wetlands are important ecosystems with a myriad of functional values such as habitat, erosion control, water quality, and flood control.

The classification system used in the wetland inventory can be defined as follows:

1. Marine

Consist of the open ocean areas overlying the continental shelf that are associated with a high-energy coastline. They are exposed to the waves and currents of the open ocean, and the Marine system extends from the outer edge of the continental shelf shoreward to one of two lines:

a. The landward limit of tidal inundation

b. The seaward limit of the Estuarine System

2. Estuarine

Consist of deep water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land, but are connected to the ocean; in which ocean water is at least occasionally diluted by freshwater runoff from the land. This system extends upstream and landward to where ocean-derived salts measure less than 0.5 percent during the period of average annual low flow; to an imaginary line closing the mouth of river, bay or sound; and to the seaward limit of wetland emergent, shrub, and trees. The Estuarine system also includes offshore areas of continuously diluted seawater and lagoons.

Estuarine wetlands may be divided into subtidal and intertidal subsystems. In the subtidal subsystem the substrate is continuously submerged, whereas in the intertidal subsystem the substrate is exposed and floods only during high tides.

3. Riverine Wetlands

Includes all wetland and deep-water habitats contained within the river channel, with two exceptions:

a. Wetlands dominated by trees, shrubs, persistent emergent, mosses, or lichens.

b. Habitats with water containing ocean-derived salts in excess of 0.5 percent.

The Riverine system is bounded on the landward side by upland, channel bank, or wetlands dominated by trees, shrubs, persistent emergent, mosses, or lichens. Termination occurs at the downstream end where the concentrations of ocean-derived salts in the water exceed 0.5 percent during the period of annual average low flow, or where the channel enters a lake and at the upstream end where tributary steams originate, or where the channel leaves a lake. The Riverine is divided into four (4) subsystems:

a. Tidal - the grading is low and water velocity fluctuates under tidal influence,

b. Lower perennial- the grading is low and water velocity is low,

c. Upper perennial - the grading is high and velocity of the water fast, and

d. Intermittent - the channel contains non-tidal flowing water for only part of the year.

4. Lacustrine

This system includes wetlands or deep-water habitats with the following characteristics:

a. Situated in topographic depression or a dammed river channel,

b. Trees, shrubs, persistent, emergent, mosses or lichens with aerial coverage greater than 30 percent, and

c. Total area exceeds 0.08 km2 (0.03 square miles).

The Lacustrine system is divided into two subsystems: limnetic and littoral. The limnetic subsystem includes all deep-water habitats within the lacustrine system and in the littoral, all wetlands habitats in the lacustrine system. It extends from the shore boundary of the system to a depth of 2 m (6.6 feet.) below water or to the maximum extent of non persistent emergents, if these grow at depth greater than 2 m.

5. Palustrine

Includes all non-tidal wetlands dominated by trees, shrubs, persistent emergent, mosses or lichens and all such wetlands that occur in tidal areas were the salinity due to ocean-derived salts is below 0.5 percent. It also includes wetlands lacking the above mentioned vegetation, but with the characteristics: area less than 8 ha (20 acres), active wave-formed of bedrock shoreline feature lacking water depth in the deepest part of the basin less than 2 m (6.6 feet) at low water, and salinity due to ocean-derived salts measuring less than 0.5%. This system is bounded by upland or by any of the other four systems. The Palustrine system was developed to group the vegetated wetlands; traditionally known as swamp, marsh, bog, prairie and/or ponds and it is a system that lacks subsystems.

V. METHODS

The information available was congruent and permit us characterize the site vegetation, soils and hydrology. Therefore, a "Routine Approach-On Site Inspection", was used for this jurisdictional delineation. Note that both the wetland definitions, as well as the indicators used, have the underlying assumptions of normal conditions.

A systematic sampling approach was developed along the studied area. See figure 8 Sampling Design. A total of three transects with point counts were established. Transect 1 is 100 meters long with 2 points counts; Transect 2 is 200 meters long with 3 point counts and Transect 3 is 250 meters with 3 point counts.

Soils and hydrologic data were collected from an 18" deep by 6" wide soil-bore hole at each sampling site. Refer to Appendix B: Photos, that shows soil sample collection and analyse. Vegetation was observed and identified around the point sampling site in a 5 meters diameter. Please refer to Figure 8: Sampling Design for the Study Site. It shows points (point counts) over aerial image. Refer to Table 4 that summarizes GPS points coordinate, given in degrees minutes and seconds (hddd° mm'ss.s") on NAD 83 Harn Datum.

Table 4: GPS Coordinates

Sampling Site	Waypoint	lat	long	y_proj	x_proj
T1A	1628	18.4661	-66.411	2043716	773420
T1B	1629	18.4662	-66.411	2043718	773413
T2A	1630	18.466	-66.412	2043702	773355
T2B	1631	18.4665	-66.412	2043751	773339
T2C	1632	18.4653	-66.411	2043619	773392
T3A	1633	18.4658	-66.412	2043682	773285
T3B	1634	18.4662	-66.413	2043717	773213
T3C	1635	18.4658	-66.413	2043675	773229

This inventory was complemented with computerized (ERDAS Imagine) analysis of high-resolution aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography according to the classification system developed by Cowarding, et al (1979). Remote sensing techniques were applied to categorize color bands and depict wet areas by means of infrared bands. The aerial photographs typically reflect conditions during the specific year and season when they were taken. In addition, there is a margin of error inherent in the use of aerial photographs. Thus, a detailed field survey using submetric GPS (Leica GS20) , real time and WAAS enabled to located specific boundaries with a precision degree of less than 10cm per waypoint.

A sub metrical GPS Leica GS20 using DGPS and post processed data was used to take geo referenced points associated to sampling points, upland and wetland boundaries. All data collection and GIS/RS database was projected on the Lambert Conformal Conic with the NAD 83 datum.

All geographical data and figures were developed and processed using ArcGIS 9.1 with extensions from ESRI and the imagery was analyzed using ERDAS Imagine 8.7 for RS. A total of 8-point counts were sampled and geo-referenced to existing datasets. Also a series of points were collected with the GPS Leica GS20 to define property lines and wetland boundaries. Please refer to Figure 9: Jurisdictional Delineation Boundaries.

This GIS/ Remote sensing involved compiling existing data, creating new digital data, and geoprocessing digital data including among others;

1) NWI polygon data,
2) Digital line graph (DLG) hydrology coverage for study area quad
3) Digital raster graphics (DRGs) and digital ortho quad (DOQ) for study quads

4) Aerial and Satellite RS imagery

The NWI polygon data served as the prime source of wetland habitat data, while the DLG hydrology layer was the major source of stream data. DRGs were used as collateral data to evaluate wetlands that were not readily identified as isolated or non-isolated. The analysis was a series of a GIS operations complemented with real data.

A. Vegetation: As used in the definition, a prevalence of vegetation refers to the dominant vegetation plant community or communities in an area at some point in time. For the area to be considered a wetland, the prevalent vegetation must consist of macrophytes that are typically adapted for life in flooded or saturated soils. Operationally, it is determined that a positive wetland vegetation indicator is present when more than 50 percent of the dominant plant species are:

1. Obligated Wetland Plants (OBL) - Plants that occur almost always (probability > 99°) in wetlands under natural conditions, but which may occur rarely (probability < 1%) in non-wetlands.
2. Facultative Wetland Plants (FACW) - Plants that occur usually (Probability 67% to 99%) in wetlands, but also occur (probability 15 to 33%) in non-wetlands; 3. Facultative Plants (FAC) - Plants with a similar likelihood (probability 33% to 67%) of occurring in both wetlands and non-wetlands.

B. Soils: According to the 1987 USA CoE Wetland Delineation Manual, only hydric soils that support hydrophitic vegetation may be classified as wetland soils. A hydric soil is saturated or flooded for a long enough period during the growing season to develop anaerobic conditions (U.S. Department of Agriculture, Soil Conservation Service, 1985, and Technical Committee for Hydric Soils, 1986).

The following criteria for sandy soils were used during this jurisdictional

delineation:

1. Occurrence of organic soil - Qualitative estimates of organic matter content was used as indicators of sandy hydric soils by observing whether the following conditions were present:
    a. High organic matter content in the surface horizon.
    b. Streaking of subsurface horizons by organic matter.
    c. Organic pans.

2. Soil color - Grayed or low matrix chrome «1). It was determined that a positive wetland soil indicator was present when: (a) more than 50 percent (by volume) of the upper 32 inches of soil is composed of organic soil material; or (b) organic soil material of any thickness rests on bedrock. Organic soils are saturated for long periods and are commonly called peat or mucks. Note that during the determination the soil color criteria were used as an indicator for non-sandy soils only. Our field survey shows that most of the land is composed of Rio Lajas sands. (Figure 5: Soils Map).

C. Hydrology: The 1987 USA CoE Wetland Delineation Manual defines wetland hydrology as all hydrologic characteristics of areas that are periodically inundated or have soils saturated to the surface at some time during the growing season.

The following hydrologic criteria were used during this jurisdictional delineation.

1. Visual observation of inundation - Standing waters occurring at the site.
2. Visual observation of soil saturation - Water level in a soil pit is less than 18 inches from land surface.
3. Tide elevation - Site is within the intertidal zone.
4. Physiological adaptations-Occurrence of gas-exchange structures in woody vegetation. The studied area is practically divided in half upland and half wetland due to hydro modifications conducted in the recent past. Including among others drainage channels for the urban developments,

sand extraction and open pits.

Water is the principal feature of a wetland. The occurrence, quantity and movement of water (the hydrologic regime) are fundamental to the functional values that a particular wetland possesses. Furthermore, the hydrologic regime controls the wetland diversity found in a given area. The hydrologic regime is the most important factor controlling the wetlands' plant composition, succession and zonation.

The hydrologic regime may be defined in terms of:

1. Water sources - the source(s) of water that subsidize a wetland,
2. Hydroperiod - duration, depth and frequency, with which floodwaters occurred,
3. Water flow - movement of water within the wetland, in terms of velocity and direction.

Direct rainfall, overland runoff, stream flow and ground water are sources to wetlands. The other two components of the hydrologic regime, hydroperiod and water flow are intimately related to the water sources. The differences between water inputs and outputs result in water storage or deficit. Water storage within a wetland will determine whether standing waters will occur at any particular time. The hydroperiod is expressed in terms of duration, frequency, and depth at which the flooded water occurs within a wetland.

VI. RESULTS

After groundtruthing and field sampling, we found jurisdictional wetlands within the studied area.

According to the National Wetlands Inventory, we may find in the study area the following associations; See Figure 6 Wetlands Inventory Map

PEM1A: Palustrine Emergent, Persistent, Temporarily flooded

PEM1H: Palustrine Emergent, Persistent, Permanently flooded

PFO3C: Palustrine Forested, Broadleaved Evergreen, Seasonally Flooded

U : uplands

The vegetation along the studied area is diverse in composition and structure. Plant species are associated to various formations including coastal thickets, herbaceous wetlands and secondary forest formations. Secondary species associated to mature forest exists in small fragments like *Clusia, Chrysobalanus, Calophyllum, Hymenae, Tababebuia* and *Ficus citrifolia*. A large herbaceous wetland composed mainly of *Cladium, Blechnum, Typha* and Cyperus. Coastal forest contains *Myrica, Andira, Miconia* and Ouratea.

Soils along the property include Corozo fine sands, Algarrobo fine sands and Tiburones Muck. Corozo fine sands and Algarrobo fine sands are considered non-hydric soil (Soil Conservation Service, 1993).

The studied area does not contain any natural hydrographical features as river or creeks. Laguna Tortuguero is the nearest water body around. High tables water are evident and influenced to tidal regimes.

The vegetation, soil and hydrologic data were used to delineate the area that met the wetland jurisdictional criteria. Figure 9 Jurisdictional Delineation of existing wetlands shows the results of the jurisdictional determination. Table 5 summarizes the field results of the wetland jurisdictional determination based on the three indicators used (vegetation, soils, and hydrology).

Table 5 - Summary of the field survey for wetland indicators

Sampling Site	Vegetation Indicator	Soil Indicator	Hydrology Indicator	Wetland Determination
T1A	Positive	Negative	Positive	Positive
T1B	Negative	Negative	Negative	Negative
T2A	Negative	Negative	Negative	Negative
T2B	Positive	Negative	Positive	Positive
T2C	Positive	Positive	Positive	Positive
T3A	Positive	Negative	Positive	Positive
T3B	Negative	Negative	Negative	Negative
T3C	Positive	Positive	Positive	Positive

The remote sensing and GIS effort included the categorization of aerial imagery. Images were analyzed for color in the infrared spectrum to check for wet sites. Please refer to Figures 10 and Figure 11 Infrared Image, Categorization.

VII. WETLANDS' FUNCTIONAL VALUES

Wetlands' functional values were evaluated following Wetland Evaluation Technique (WET) method developed by Federal Highway Administration. The main area of evaluation is the drainage channel.

WET evaluates 11 different functions and values and assigned a qualitative probability rating of HIGH, MODERATE, or LOW to the functions in terms of: social significance, effectiveness, and opportunity.

> Social significance refers to the importance society may attach to the wetland due to recognition-of its natural features, potential economic value, or strategic location.
>
> Effectiveness refers to the capability of a wetland to perform a function due to its physical, chemical, and biological attributes.
>
> Opportunity refers to the chance a wetland has to perform a function.

The wetland functions and values to be evaluated are groundwater recharge, groundwater discharge, flood-flow alteration, sediment stabilization, sediment toxicant retention, nutrient removal transformation, production export, wildlife diversity/abundance, aquatic diversity/abundance, uniqueness heritage, and recreation.

Table 6 shows the results of the functional values evaluation conducted for wetlands in the study area.

Table 6: Functional value evaluation for wetlands in the study area

FUNCTIONAL VALUE	SOCIAL SIGNIFICANCE	EFFECTIVENESS	OPPORTUNITY
Groundwater Recharge	High	High	High
Groundwater Discharge	High	High	High
Flood flow Alteration	Moderate	Moderate	Moderate
Sediment Stabilization	Moderate	Moderate	Moderate
Sediment Toxicant Retention	Moderate	Moderate	Moderate
Nutrient Removal Transformation	Moderate	Moderate	Moderate
Production Export	Moderate	Moderate	Moderate
Wildlife Diversity/Abundance	High	High	High
Aquatic Diversity/Abundance	High	High	High
Uniqueness Heritage	Moderate	Moderate	Moderate
Recreation	Low	Low	Low

VIII. CONCLUSION

A wetland jurisdictional delineation was conducted at a parcel of land comprised of approximately 32 acres adjacent to state highway PR 687 at Guarico Ward in Vega Baja, Puerto Rico. The wetland delineation was conducted following the guidelines of the 1987 US Army Corps of Engineers Wetland Delineation Manual. A "Routine Approach, On site Inspection" was used for this jurisdictional delineation. Accordingly, characterizing the vegetation, soils and hydrology of the study area developed this wetland jurisdictional delineation.

The soils in the wetland area were found to be Corozo fine sand and Algarrobo fine sand, which are classified by the US Soil Conservation Service as non hydric soils.

A photo-chronograph was assembled to evaluate land uses changes, particularly table water changes reflected in vegetation coverage. A series of photos from 1984, 1998, 2002 and 2004 were evaluated. Increasing water table levels potentially exerts changes in coverage.

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